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ABSTRACT

This paper presents a brief review of the literature on instructional theory and a brief rationale for the development of such theory, then discusses an ongoing project in developing such theory from basic postulates of learning. An overview of a comprehensive, integrated learning model, based on information processing theory and necessary for instructional theory development, is presented. It postulates two basic types of learning ("boosting" and "chunking") and integrates cognitive, behavioral, and affective elements into mental units called schemes. Instructional theory is developed as a sequence of instructional processes (IPs), each with sub-processes, and often preceded by analytic processes (APs) involving both the learner and the task. The paper then indicates some of the difficulties experienced by students of educational psychology in creating practical applications, and describes the insights which have emerged from the endeavor as a whole.
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Development of Instructional Theory
from Learning Postulates

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Abstract

This paper presents a brief review of the literature on instructional theory, and a brief rationale for the development of such theory, then discusses an ongoing project in developing such theory from basic postulates of learning. It presents an overview of a comprehensive, integrated model of learning based on information processing theory, developed for this purpose, and argues that such a comprehensive model is necessary for instructional theory development. It then discusses the form and extent of the instructional theoretic formulations developed thus far, and mentions some of the difficulties experienced and the insights which have emerged from the process.

Development of Instructional Theory
from Learning Postulates

In Toward a Theory of Instruction (1966), Jerome Bruner espoused the development of instructional theory and described the form it should take. He also presented broad examples of applications, but did not develop a formal theory. A year before, in Conditions of Learning, Robert Gagne developed what he described as a "learning theory"; its "conditions," however, were prescriptions for instructional processes, developed from postulates of learning. Initially narrow in scope, mainly behavioral, these postulates have since been extended to include cognitive considerations. His most recent (fourth) edition appends the words "and theory of instruction" to the title.

In The Technology of Teaching (1968), B. F. Skinner developed instructional processes from his own learning principles. While primarily behavioral, they implied cognitive processes (as did his research on verbal behavior): for example, in programed instruction it became necessary to incorporate concept teaching processes to achieve cognitive criterion behaviors (Markle and Thieman, 1970). However, Skinner did not frame his work in the form of theory.

During the same era Piaget talked of pedagogy as a science and of the need to develop a discipline to mediate between psychology

on the one hand and teaching on the other (1970). Case's "developmental theory and technology of instruction" (1978) derived prescriptive guidelines from Piagetian learning principles; however, this developmental orientation made it necessary to take a number of conventional teaching processes for granted, and thus it was not a comprehensive model.

Atkinson (1972) espoused instructional theory development and laid down guidelines derived from control theory: however, his experimental work used relatively few basic instructional processes and focussed on optimization of learning by manipulating parameters such as degree of difficulty and amount of repetition of examples. Thus it explored one facet of instructional theory, but did not lay down formal theorems. Glaser (1978) extended Dewey's (1911) concept of a "linking science" to what he called "instructional psychology": the guidelines were similar to those of Atkinson, but the research emphasized task analysis and analysis of problem-solving processes, rather than focussing on instructional processes per se, and thus was not "instructional theoretic" in the sense used here.

There are other models of instruction which are generalizable and formal enough to be considered instructional theory, but which deal with teaching over longer periods of time: we view these as "macro-theoretic," where "micro-theory" deals with basic teaching acts which take place in minutes or hours at the most (some

processes bridge the gap between the two, of course.) Among these are the "elaboration" theory of Reigeluth et al. (1979), Joyce and Weil's models of teaching (1980), and some of the processes reviewed by Haertl et al. (1983) (the latter refer to this category as "holistic.")

All in all, there has been relatively little development of instructional theory per se, and not a great deal more in the way of metatheory. The fact that one of the oldest and most widely practiced professions, teaching, has no comprehensive or widely accepted theoretical foundation seems surprising, but there are a number of factors to which one may attribute this state. One was identified by Resnick (1981), who noted that there is no comprehensive model of learning on which to base such a theory. This was partly explained by Tuthill and Ashton (1983), who pointed out that researchers and scholars do, and in their opinion should, stay within relatively limited paradigms to develop their theory and research, only rarely indulging in the cross-paradigmatic theorizing that they termed "extraordinary." Also relevant is the fact that in the literature on learning there is relatively little attention given to the acquisition of knowledge as compared with that involved with retention and retrieval: current interest in "elaboration" and in acquisition of "learning strategies" indicates some change in this bias, as in Weinstein and Mayer (1982).

Philosophically, the concept of instructional theory is "positivist" or "instrumentalist," and as such runs counter to the current zeitgeist. Snow (1977) attacked the concept as incompatible with individualist concepts, particularly that of aptitude-treatment interactions. Another philosophic difficulty is the assumption that theory development implies domination of one view of learning or teaching over others: as Eisner said in a debate with Phillips (1983), "Given a choice between risking an approach to inquiry that leads to a Tower of Babel or the uniformity of a single party line . . . I would choose the Tower of Babel." In other debates, the concept of instructional theory is rejected by both parties, as when Kerlinger asserted that the objective of research is not the solving of social problems or taking action, to which Scriven replied that we are seeking solutions to problems, but that such a search does not require theory (1973).

Finally, the development of prescriptive theorems of instruction from descriptive learning postulates is a difficult task. Resnick noted (1976) "Instruction itself is a very delicate matter. There are no simple rules for constructing situations that will convey the concepts or processes to be taught in a clear way. Even with an appropriate task analysis, the mapping from identified components to instructional strategies remains very much a matter of artful development." Resnick is ambiguous about the feasibility

developing such "simple rules," a process which is central to instructional theory: however, she leaves no doubt as to the difficulty of the task.

While the desirability and feasibility of instructional theory are not universally accepted, there are compelling arguments for its further development. Such a basic structure would provide a means of relating and interpreting research in teaching, and would thus be a source of ideas for additional research. Furthermore, a comprehensive theory is needed to provide a standard to which to relate various languages and methods and philosophies of instruction (contrary to Eisner's preference for a Tower of Babel). One might go further and attribute the cyclical nature of fads and foibles in education to the lack of a stable, comprehensive model of teaching by which to judge the potential of innovations. There is also a need to validate accepted teaching processes: one way to do so is by comparative assessment of outcomes, but this is difficult and costly, particularly if done on a large scale. Another way is to derive the processes from learning principles which have themselves been validated experimentally (Olson, 1976).

Shuell (1980) presented an apt metaphorical argument for instructional theory development when, after endorsing Glaser's views regarding a linking science, he said "The two pillars on which our bridge between theory and practice must ultimately rest are still quite separate, and the ability to get from one side

to the other depends too much on the individual talent and creative ability of the individual doing the translation . . . individual talent is important, . . many teachers and instructional designers are very successful in bridging this gap . . . but what about those who are not? A scientific body of knowledge is needed that transcends this individual talent gap, or at least relies less on it for successful application." To this the author would add that no other profession relies purely on the talent of the individual to assure success in applying theory to practice, no matter how great that talent may be.

The models of learning and instruction to be described here may be regarded as needed and potentially useful alternatives. The learning model draws from information processing theory, cognitive theory, and neo-Piagetian developmental theory, as well as traditional paradigms of learning. It postulates two basic types of learning, in contrast to Gagne's eight, and integrates cognitive and behavioral elements into mental units called "schemes" (a la Pascual-Leone's "Theory of Constructive Operators," 1979), adding, however, an affective component as well. Learning is defined as a change in information processing which can come about in two basic ways. One is called "boosting," and involves increasing the probability that an existing scheme in long-term memory will be activated in the processing space (short-term memory, field of centration) of the learner. This boosting is accomplished in two

ways: the first is through arrangements of the external environment which alter the frequency and/or the salience of the associated stimuli, and thus alter the energy levels of the schemes which match those stimuli; the second is through arrangements whereby internal states of the learner (goals, needs, developmental characteristics, personality) are related to the desired schemes, and thus lend energy to those desired schemes and increase their probability of being activated (i.e. of being part of the processing space).

"Chunking," the second type of learning, brings about the combination of two or more existing schemes into a "superscheme" which has some of the characteristics of the original ones, but also new characteristics (analogous to Lorenz's "fulguration".) The superscheme can be energized by stimuli which energized the original schemes, but of course the outcomes are different. The processes which bring about this chunking are not completely understood, but we assume that it occurs when the learner "elaborates" on schemes in the processing space, i.e. holds them in the space while searching long-term memory for other schemes which are associated with them, and ideally which relate them to each other. Elaboration is facilitated in a variety of ways, including setting an example, cuing/prompting, and through reinforcement of behaviors of the learner which evidence elaboration. Elaboration is viewed as consisting of three types: comparative, integrative, and artificial, after Mayer (1981).

At any given moment in information processing the schemes in the processing space are assumed to act collectively: thought, feeling, and behavior are therefore a result of a summation of these schemes. However, there is a sharp difference between such processing and learning, which involves formation of a superscheme by holding schemes in the processing space while elaborating on them.

Conventional learning paradigms are subsumed under this model. For example, classical conditioning is accomplished by chunking schemes: the superscheme has an affective component which is the sum of the affective components of the schemes which formed it, and this amounts to "counter-conditioning" when the original affective components were opposed. Concept learning involves formation of increasingly dedicated superschemes as the learner focusses on more and more examples of the concept; i.e. the irrelevant information loses energy in the process, and the relevant becomes more and more the essence of the superscheme. Sequential learning and behavioral sequences result from the chunking of sequences of schemes, forming super-schemes which represent what are sometimes referred to as "executive schemes": with practice, these become more and more autonomous and automatic. Repetition and review lead to boosting of existing schemes and thus changes in the probabilities of thoughts, behaviors and actions. Reinforcement involves

"backward boosting," in that positive consequences act to increase the future internal support given the scheme which brought about those consequences.

Instructional theory is developed as a sequence of instructional processes, each with sub-processes, and in many cases preceded by analytic processes involving both the learner and the task. The first "IPs" prescribe processes for facilitating the boosting of existing schemes (the first type of learning), both by external means (altering the salience and the frequency of the stimuli which energize those schemes) and internal means (cueing the learner to relate internal states to the schemes to be boosted - these states involve needs, goals, developmental stage characteristics, and personality characteristics.) The nature of the learning model requires that instructional processes will be indirect; i.e. they emphasize that the instructor tries to facilitate changes which are ultimately controlled and brought about by the individual learner, and that there is many a possible slip between cup and lip, as it were.

The analytic processes (APs) which precede many of the instructional ones (IPs) focus on procedures for determining initial states of the learner, both cognitive and affective and behavioral, and for determining the nature of the task by analyzing the cognitive processes of some model (the "expert" in

Cass's approach.) Thus the theory discriminates between analytic procedures and those which are designed to facilitate changes, i.e., instruction.

Later theorems outline steps by which one facilitates chunking of schemes, i.e. by modelling and cuing and reinforcing those elaboration processes which are crucial to such acquisition. Then corollaries deal with particular applications of this process, i.e. counterconditioning (combining positive and negative affect), concept teaching (via examples and non-examples, facilitating chunking in each case), and teaching cognitive sequences and motor skills (by presenting stimuli in the appropriate sequence, facilitating chunking of the sequence, and subsequent practice that leads to automatization of the sequence.)

These instructional processes are presented as a series of prescriptive steps. Each step is justified in terms of postulates of learning. Then examples of applications of the steps are given involving particular subject matters or contexts, i.e. arithmetic, learning disabilities, athletic skills, or therapeutic procedures. In using this theoretical structure as an adjunct to a conventional course in educational psychology, the author asks students to create examples of the various analytic and instructional processes in the context of their own special teaching areas, whether third grade social studies, tenth grade biology, learning disabilities, early childhood education, or teaching writing to college students (all

have been involved in classes so far.) While the potential usefulness of this task in the application of learning and teaching theory is obvious, it turns out to be a difficult task for most students, whether experienced teachers or prospective ones. Therefore, a mastery learning process is used, where students respond to questions by the author, clarify parts of their processes, and thus improve on each draft.

The difficulties experienced by students in creating applications, even though given step-by-step guidelines, has made it increasingly clear why in the past both prospective and experienced teachers have had difficulty in making practical use of educational psychology courses. It has also increased the author's satisfaction with his teaching of that subject. More than that, the development of instructional theory has forced the author to confront hitherto-unappreciated problems and gaps relevant to teaching and learning - as Atkinson predicted would be the case (1972). Thus the potential impact of this area of scholarly endeavor is broader and more fundamental than the obvious one of increasing the sophistication and range of students' understanding of teaching: it also expands our basic understanding of both teaching and learning.